4\8\05

10/533518
JC20 Rec'd PCT/PTO 28 APR 2005
Docket No.: HO-P03170US0

ELECTRIC PRESS DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a national stage filing of PCT/DE03/03338 filed October 9, 2003 claiming priority to DE 10251387.2 filed November 1, 2002.

TECHNICAL FIELD

[0002] The invention relates to an electrical press device with an electric motor, a step-up gear, a spindle drive in the form of a satellite roller screw, the thread spindle of which is connected to the step-up gear and the threaded nut of which is guided in a cylindrical housing in a non-rotatable manner, and such that it can be axially displaced, and is connected to a pressing tool, for converting a rotary motion of the electric motor into a linear motion of the pressing tool, a travel sensor for determining the distance traveled by the pressing tool, and a sensor for determining the pressing force of the pressing tool.

BACKGROUND OF THE INVENTION

[0003] A press device of this kind is known from DE 100 11 859 C2, in which the thread spindle is supported against the housing in the axial direction by a flange shoulder and a tapered roller bearing. The tapered roller bearing is only secured against axial displacement on the thread spindle by means of a retaining ring and can in effect not transfer any axial forces in the direction of traction. Nor is this necessary in the known pressing-in device, since pressing forces merely have to be generated in one direction (the direction of pressing).

[0004] The invention sets out to achieve the object of developing an electrical press device of the kind described at the beginning such that pressing forces (traction and pressing forces) can be generated, the aim being to keep the diameter of the cylindrical housing as small as possible.

[0005] A further object of the invention consists in providing an electrical press device that can be firmly attached to a machine frame or the like in a freely selectable manner with regard to its axial position. This is not possible in the known press device, since the housing there is equipped with a mounting flange, so that the press device can only be attached in a predetermined position.

[0006] A further object the invention consists in providing a simpler structural design for the guide for the threaded nut of the spindle drive, which is non-rotatable and can be axially displaced relative to the housing.

BRIEF SUMMARY OF THE INVENTION

[0007] The first-mentioned object of the invention is achieved by an electrical press device with an electric motor, a step-up gear, a spindle drive in the form of a satellite roller screw, the thread spindle of which is connected to the step-up gear and the threaded nut of which is guided in a cylindrical housing in a non-rotatable manner, and such that it can be axially displaced, and is connected to a pressing tool, for converting a rotary motion of the electric motor into a linear motion of the pressing tool, a travel sensor for determining the distance traveled by the pressing tool, and a sensor for determining the pressing force of the pressing tool, the press device being characterised by the fact that the thread spindle is mounted in the housing by means of a pre-loaded set of angular contact ball bearings, the first angular contact ball bearing(s) of which is (are) suitable for supporting traction forces and the second angular contact ball bearing(s) of which is (are) suitable for supporting pressing forces, the inner rings of the angular contact ball bearings being contiguously clamped by a lock nut against a shaft shoulder of the thread spindle, and the outer rings of the angular contact ball bearing being contiguously clamped by a housing nut against a housing shoulder, so that substantially equally great traction or pressing forces can be supported without any axial play.

[0008] It can be provided for the set of angular contact ball bearings to have two first and two second angular contact ball bearings.

[0009] It is advantageously provided for the step-up gear to be designed as a multi-stage transmission, where the step-up gear may have a transmission ratio of, for example, i=5.

[0010] It is conveniently provided for the electric motor to be controlled electrically and to have an angle encoder on the motor shaft, a means being present to determine the path traveled by the pressing tool by reference to the angle signals of the angle encoder, the transmission ratio of the step-up gear and the thread pitch of the spindle drive.

[0011] It is advantageously provided for a torque sensor to be disposed between an output shaft of the step-up gear and the thread spindle. The torque sensor may have a transmitter

for transmitting measured data contact-free. The torque sensor is preferably easily accessible and exchangeable in order for it to be adapted to different pressing forces. In this way, it is possible to make as full a use as possible of different measuring ranges of torque sensors, even with different pressing forces, so that the accuracy of measurement increases.

[0012] It is advantageously provided for there to be a closable opening in the housing, offering access to the torque sensor.

[0013] The invention further provides that there is a motor brake disposed on the motor shaft, which is applied in the absence of current and is released when current is carried. This ensures that, even if a transmission does not stop automatically, any motion of the press device is prevented in the event of a power failure.

[0014] It is advantageously provided for there to be a sprung stop between the threaded nut and the housing for determining the zero position of the travel measuring device.

[0015] The stop can be designed as a sprung ring on the threaded nut.

[0016] The thread spindle preferably has a multiple-start, especially five-start, thread.

[0017] The threaded nut can be retained in an axially stepped support sleeve, which is guided in the housing in a non-rotatable manner, and such that it can be axially displaced.

[0018] In a preferred embodiment, it is provided that the support sleeve is connected to, or forms, an inner sleeve of an axial guidance system with recirculating ball bearings, the outer sleeve of which is connected to the housing in a non-rotatable manner.

[0019] The support sleeve can have a cylindrical supporting part with a relatively large diameter and a smaller-diameter sleeve bolted to it, forming the pressing ram.

[0020] The housing preferably has an outer cylindrical clamping surface for fixing the press device in a freely selectable axial clamping position.

[0021] For this purpose, a double-cone set of clamps can be disposed on the clamping surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Further advantages and features of the invention will become apparent from the following description of a preferred embodiment, reference being made to a drawing in which:

[0023] Fig. 1 shows a partially cut side elevation of a press device in accordance with the invention;

[0024] Fig. 2 shows an enlarged detail from Fig. 1 in the region of the set of angular contact ball bearings;

[0025] Fig. 3 shows an enlarged detail from Fig. 1 in the region of the axial guidance system with recirculating ball bearings;

[0026] Fig. 4 shows a cross-sectional elevation along line IV - IV in Figs. 1 or 2; and

[0027] Fig. 5 shows a cross-sectional elevation along line V - V in Figs. 1 or 3.

DETAILED DESCRIPTION OF THE INVENTION

[0028] Referring first to Fig. 1, which shows an electrical press device according to the present invention in a partially cut-out side elevation: major components of the press device are an electric motor 2 with a motor brake 6 acting on its motor shaft 4, a step-up gear 8, a torque sensor 10, a set of angular contact ball bearings 12, in which is carried a thread spindle 14 which, together with a threaded nut 16, forms a spindle drive 66, and a support sleeve 18 retaining the threaded nut 16, said support sleeve for its part being carried in an axial guidance system with recirculating ball bearings 20, which in turn is supported in a cylindrical housing 22 which has a cylindrical outer clamping surface 24 for fixing it in a freely selectable position on a machine part 26 or the like by means of a set of clamps 28.

[0029] Disposed on the motor shaft 4 is an angle encoder 30 as a zero-based measurement sensor, and there is a resolver 32 present to evaluate the signals of the angle encoder in order to obtain a distance signal. This is done by referring, in a known manner, to the

transmission ratio of the step-up gear 8 and the thread pitch of the spindle drive 66 (thread spindle 14, threaded nut 16).

[0030] The motor brake 6 is designed such that it is applied by means of springs in the absence of current and prevents the motor shaft from rotating, but is released when the power supply is present.

[0031] The step-up gear 8 could be designed as a planetary gear, though in the preferred embodiment it is designed as a multi-stage transmission with a transmission ratio of e.g. i=5. An input shaft 34 of the step-up gear 8 is connected to the motor shaft 4, while an output shaft 36 of the step-up gear is connected to the thread spindle 14 and carries the torque sensor 10. The torque sensor 10 is equipped with a transmitter, so that wireless or sliding-contact-free transmission of the measured values is possible. The torque sensor 10 is relatively easily accessible via a closable opening in the housing 38 and is therefore easy to exchange, so that a torque sensor can be used which is adapted in each case to a pressing force to be achieved in that particular case. This offers the advantage that, with a torque sensor that is adapted to a particular maximum torque/pressing force, as full a use as possible can be made of the measuring range of the torque sensor, so that the measuring accuracy is maximized. In this way, an accuracy of less than 1 % of the maximum or ultimate value can be achieved, and thus also a corresponding accuracy in setting a desired pressing force, which is determined by the torque.

[0032] The thread spindle 14, now referring also to Figs. 2 and 4, is carried in the housing 22 by means of a set of angular contact ball bearings designated as a whole by 12, which in the present case has a bearing sleeve 40 and an outer guide 42 bolted to it.

[0033] In the embodiment described here, the set of angular contact ball bearings 12 consists of a total of four angular contact ball bearings, each of which can support the same axial and radial forces, which is indicated by resultant load vectors 44 running at 45° to the longitudinal axis 50.

[0034] Two first angular contact ball bearings 46 are disposed in each case to support traction forces (acting towards the left in Figs. 1, 2), and two second angular contact ball bearings 48 are disposed in each case to support pressing forces (acting towards the right in Figs. 1, 2). The inner rings of the angular contact ball bearings are directly contiguously clamped by a lock nut 52 against a shaft shoulder 54 of the thread spindle, while the outer rings of the angular

contact ball bearings are correspondingly contiguously clamped by a housing nut 56 against a housing shoulder 58. The angular contact ball bearings are manufactured in such a way that, when the lock and housing nuts are tightened, no play remains, but, on the contrary, the two pairs of bearings 46 and 48 aligned in opposite directions are pre-loaded, so that substantially the same traction or pressing forces can be supported without any axial play occurring. A further advantage of this construction is that no particular dimensional tolerances need to be observed in the region of the bearing sleeve or the thread spindle, as far as the axial dimensions are concerned, since tightening the inner and outer rings with the lock or housing nuts is sufficient for faultless functioning without any play.

[0035] Adjoining the shaft shoulder 54 is the thread spindle 14 with, in this case, a five-start thread portion 60, the length of which is dimensioned such that the desired pressing tasks can be performed.

[0036] With its thread portion 60 and the threaded nut 16 and rollers, the thread spindle 14 forms the spindle drive 66, which takes the form of a satellite roller screw (also referred to as a planetary roller thread spindle drive). The threaded nut 16 is connected to the support sleeve 18 in a non-rotatable manner by means of a feather key 68, which can be moved in the axial direction inside the outer guide 42. Fastening bolts 70 fix the threaded nut 16 within the support sleeve 18 via a fastening ring 72, with a ring 76 sprung by means of pressure springs 74 forming a sprung stop on the fastening ring 72 or the support sleeve 18. When the spindle drive moves backwards (towards the right) the threaded nut with the ring 76 runs up against the housing shoulder 58 of the bearing sleeve 40, as a result of which the torque sensor 10 detects an increase in torque, so that it is possible in this way to determine the zero position.

[0037] The support sleeve 18 is formed from a supporting part 18a with a relatively large diameter retaining the threaded nut 16, and a sleeve 18b with a smaller diameter bolted to it and forming the pressing ram. The sleeve 18b is carried in, or forms, an inner sleeve of the axial guidance system with recirculating ball bearings 20 (Figs. 3 and 5), the outer sleeve 21 of which is secured in the housing or the outer guide 42 by retaining rings 77 such that it cannot be axially displaced and is connected to it in a non-rotatable manner by means of a feather key 78. A pressing tool (not shown) is mounted on the end of the sleeve 18b.

[0038] The set of clamps 28 has conical clamping members, with which the press device can be fixed to the machine part 26 in a freely selectable axial clamping position on its outer guide 42.